

Claims 6-13 stand rejected under 35 U.S.C. §112, second paragraph for indefiniteness regarding the solution contents in step (b) of claim 6 and the type of hydroxyl group anion-exchanger. Claim 6 has been amended to indicate that the solution of step (b) includes both aluminum and lanthanum. Claims 1 and 6 have been amended to clarify that the hydroxyl group anion-exchanger is inorganic. The specification demonstrates that claims 1 and 6 were intended to read on inorganic hydroxyl group anion-exchangers at paras. 15, 17 and 22. No new matter has been added. Withdrawal of the indefiniteness rejection is respectfully requested.

Claims 1-13 stand rejected under 35 U.S.C. §103(a) for obviousness over U.S. Patent No. 5,115,085 to Hamano et al. in combination with each of U.S. Patent No. 3,853,789 to Warthen et al. and U.S. Patent No. 5,573,582 to Inui et al. Applicants respectfully traverse this rejection for the following reasons.

The present invention is directed to a method of preparing lanthanum-stabilized transitional alumina with high thermal stability by treating a solution of aluminum (with addition of a lanthanide series element such as La) with an anion-exchanger to produce hydroxides of aluminum and the lanthanide series element, such as Al(OH)_3 and La(OH)_3 . The resulting composition is freeze dried, yielding a powder that is subsequently dehydrated to produce particulates of La-stabilized γ -alumina. Claim 1 now specifically requires the use of lanthanum and, claim 6 already requires the use of a lanthanide series element. The freeze-drying step is particularly useful in maintaining the specific surface area of the aluminum in contrast to thermal drying techniques, which are detrimental to the alumina. While techniques relating to use of anion-exchangers and freeze-drying have been described in the prior art, their combined use as in the present invention has not been taught or suggested. The combination of these features of the claimed invention yield complete stabilization of γ -alumina (as evidenced by standard industry test of 3 hours hold at 1200°C) at very low concentrations of La – from 0.1 to 0.3 molar %. Lanthanum is a very costly component, hence opportunities to reduce the level of its use are very desirable.

The Hamano patent discloses a process for producing alumina from a solution of aluminum sulfate and a lanthanum compound. The solution is thermally dried as described in the Example cited in the Office Action. No anion exchange of the aluminum or lanthanum compounds are considered nor is there any suggestion that any other drying technique would be suitable. These features are not taught or suggested by the cited secondary references as discussed below. As a result, the method of the Hamano patent can produce La-stabilized of γ -alumina only at relatively high concentrations of La. Moreover, Hamano specifically teaches away from using low levels of La (as required in claim 11) at col. 4, ll.54-58:

If the amount of lanthanum to be added is lower than 1 part by weight based on 100 parts by weight alumina [which corresponds to about 0.3 molar % La], an insufficient effect to inhibit a reduction in the specific surface area owing to the use at high temperatures will be obtained.

The Warthen patent teaches precipitation of an acid aluminum salt solution by the addition of "an alkaline reagent", but only considers that aluminum salts may be precipitated by the addition of ammonia. There is no specific teaching to use a hydroxyl group anion-exchanger. Moreover, there is no description of an intermediate hydroxide product (an aluminum hydroxide) as required in the claimed invention. In the absence of some teaching to even produce a hydroxide, there can be no motivation to use a hydroxide anion-exchanger. In addition, the Warthen patent only considers thermal drying of the reaction product and, since the additions of La were not considered, material produced according to the Warthen patent will not satisfy the requirement of high thermal stability (3 hour bake at 1200°C, a catalytic industry standard test). Consequently, such material would be useless for high temperature applications such as catalytic treatment of automobile exhaust gases, in which La-stabilized γ -alumina is a catalytic support of choice.

The Inui patent describes thermal drying of aluminum hydroxide. At col. 7, ll. 23-49, the patent specifically states that "pneumatic conveying drying" and "flash drying" are the preferred techniques for performing solid-liquid separation of an aluminum hydroxide slurry. That passage lists freeze drying as one of eight classes of drying techniques, but the patent only considers pneumatic conveying drying (characterized therein as a type of hot-air transferring drying) and flash drying as two suitable techniques of the eight potential choices for drying a slurry of aluminum hydroxide. The patent does not state that freeze drying is a viable alternative to the two techniques specifically disclosed. It only states the freeze-drying is a known technique and goes no further. There is no motivation provided for substituting some other drying technique (i.e. freeze-drying) for the only two techniques described as useful in solid-liquid separation of an aluminum hydroxide slurry.

Notice should be made that each of the Hamano and Inui patents are assigned on their faces to the same assignee, Sumimoto Chemical Co., Ltd. The conclusion by Hamano that addition of less than 1 wt.% La (i.e. about 0.3 molar % of La) seems to be a state-of-the-art knowledge shared by both inventive entities. The Inui patent teaches in that "fine-particulate oxide usually contains 0.1 to 15% by mole, preferably 1 to 10% by mole in total of other metal component in metal oxide..." which is consistent with the teachings of the Hamano patent to use over 1 mole % of La. Consequently, the low molar % of lanthanum of the present invention set forth in claim 11 is a patentable advance over the prior art of record.

Hence, the teachings of the Warthen and the Inui patents do not supplement the deficiencies of the Hamano patent. Neither of those two references alone or combination provides the motivation to use a hydroxyl anion-exchanger in producing an intermediate aluminum hydroxide, in conjunction with subsequent freeze-drying of the La-doped aluminum hydroxide. These features allow for use of extremely low concentrations of La (0.1-0.3 mole %) to achieve complete thermal stabilization of γ -alumina, as evidenced by the x-ray diffraction

patterns of γ -alumina completely stabilized with 0.1 and 0.3 mole % La in Figs. 3 and 4 of the present application and to make the stabilized alumina product very inexpensively as compared to the prior art. Hence, claims 1-13 are believed to define over the prior art of record.

Reconsideration of the rejections and allowance of claims 1-13 are respectfully requested.

Respectfully submitted,


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Marked Claims

1. (Amended) A method of preparing thermally stable transitional alumina stabilized with additions of lanthanum comprising the steps of:

- a) providing an aqueous solution of an aluminum salt and a lanthanum salt;
- b) treating the [aluminum] solution with [a] an inorganic hydroxyl group anion-exchanger to produce a composition comprising aluminum hydroxides and lanthanum hydroxides;
- c) freeze-drying the [aluminum] hydroxide composition to produce [a] an aluminum hydroxide powder containing lanthanum; and
- e) dehydrating the aluminum hydroxide powder to yield particulates of γ -alumina stabilized with lanthanum.

6. (Amended) A method of preparing thermally stable transitional alumina stabilized with additions of lanthanum comprising the steps of:

- a) providing an aqueous solution of an aluminum salt and a salt of a lanthanide series element;
- b) treating the solution of aluminum [solution] and lanthanide series element with [a] an inorganic hydroxyl group anion-exchanger to produce a composition comprising aluminum hydroxides and hydroxides of the lanthanide series element;
- c) freeze-drying the hydroxide composition to produce a powder comprising the aluminum hydroxides and the hydroxides of the lanthanide series element; and
- d) dehydrating the powder to yield particulates of thermally stable γ -alumina containing the lanthanide series element.